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Memo

Date: *March 24, 2015*

To: *RSC*

From: *D. Beavis* *& S. Polizzo*

Subject: *9 MHz Cavity testing at full Voltage*

The RSC has been asked to review what conditions are required to test the 9 MHz cavity to full power. The initial request is to test the cavity in IR4 while RHIC is operational and rely only on administrative controls to turn the 9MHz cavity off if personnel enter the area. The potential dose rate from the cavity is not known but some estimates and comments will be made below. The cavity is requested to be tested to 80kV with a 15KW power supply.

A simple estimate was conducted using MCNPX to have 80 keV electrons strike a copper target. The copper target has a 1cm thick Al shell around it, which represents the cavity structure. If 15 kW of 80 keV electrons strike the copper target the dose rate at 1 meter is 500 rem/hr. This is an extreme upper limit on the dose rate which should not be achievable.

The same simple analysis was conducted for tests in building 925 for operation at 20 KeV with a 0.5 kW power supply[1] and later for 40 keV with a 3 kW power supply[2]. In neither case were x-rays detected. For the 40 kV case the simple dose rate estimate was 8.5 rem/hr at 1 meter. For the device to generate a voltage difference most of the power goes into IR losses and only a portion of the power is available to drive electrons between the potential surfaces. S. Polizzo has conducted an analysis[3] of the power dissipation in various portions of the 9 MHz cavity. Some power losses were verified by using the water system. His analysis accounts for 99.9% of the power going into IR losses. Even if power electrons may not be emitted from the surfaces to generate x-rays. S. Polizzo's analysis suggests that the upper limit for x-ray production should at least be 100 times lower than the simple analysis. A tabulation contained in footnote 3 is given below.

[1] D. Beavis, "Testing 9 MHz Cavity in Building 925", March 4, 2015; http://www.c-ad.bnl.gov/esfd/RSC/Memos/3_04_15_CavityBldg925.pdf
[2] D. Beavis, "Extending the Conditions for Testing the 9MHz Cavity in Building 925", March 13, 2015; http://www.c-ad.bnl.gov/esfd/RSC/Memos/3_13_15_9MHzCavityBldg925.pdf
[3] S. Polizzo, Email to D. Beavis, March 24,2015.

The dose rates from the 9 MHz cavity should be at least 100-1000 times lower than the estimated 500 rem/hr at a meter. The non-detectable dose rates for the 40kV tests support this conclusion, where the radiation was at least 10,000 times lower than the simple estimate. It is suggested that a reasonable number to consider would be 500 mrem/hr at a meter.

The proposed location for the cavity test is shown in the figure below.
The use of other location on the SEB floor has also recently been discussed as an option to uncouple the testing from RHIC operations and the use of administrative procedures should the radiation levels be high.

MEASURED	Power (W)	Meas %	Sim %
Power Delivered From Amplifier	2820	100.00%	
Fundamental Power Coupler	31.56	1.12%	*0.14%*
RF Center Conductor	1439.925	51.06%	*55.70%*
Dynamic Tuner	173.58	6.16%	*0.82%*
Cap Gap Top	229.862	8.15%	*10.07%*
Cap Gap Bottom	202.51	7.18%	*6.65%*
SIMULATED	Power (W)	Meas %	Sim %
Copper End Plate	65.706		2.33%
Aluminum End Plate	95.88		3.40%
Bow Tie Tuner	100.11		3.55%
Aluminum Housing	431.46		15.30%
Stainless Ring	31.866		1.13%
Alumina Losses	14.523		0.52%
	2816.982		**99.89%**